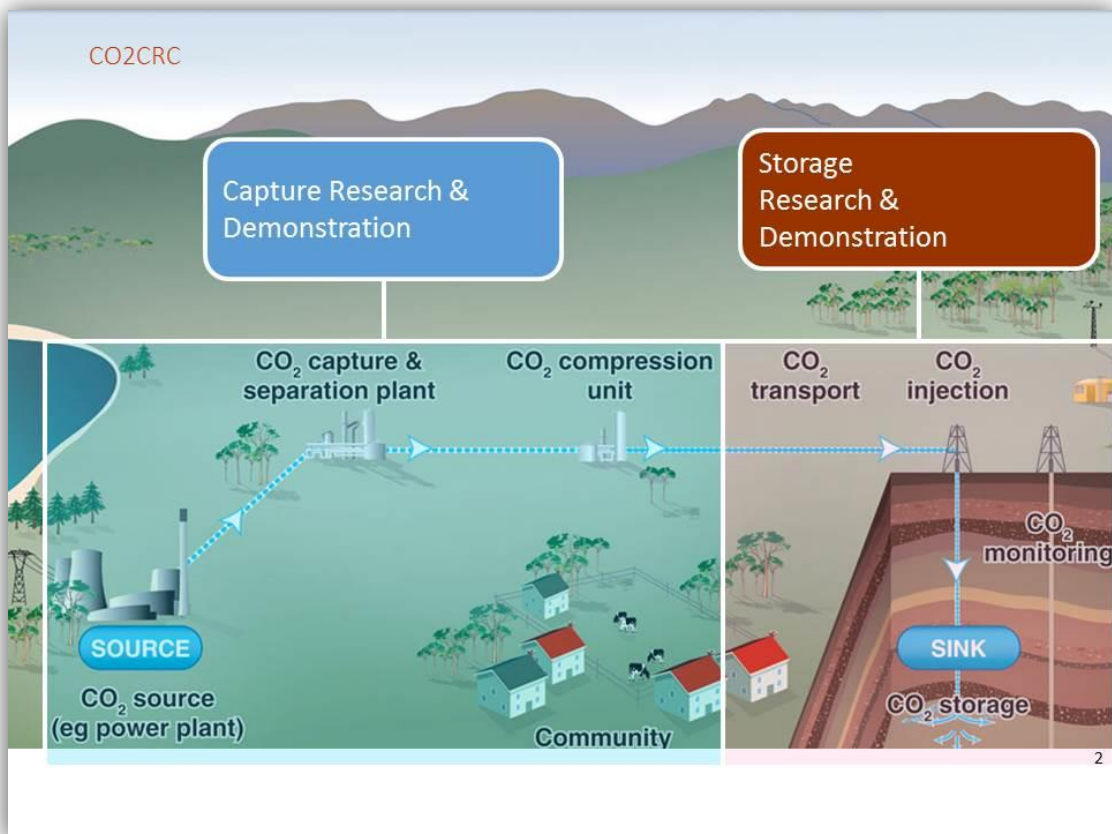


# Australian CCS Research, Development and Deployment

Shelly Murrell  
Community Liaison Officer  
CO2CRC



GCCSI  
28 October 2016



## CO2CRC the leader in Australian CCS research

1. We are the first company in Australia to have undertaken carbon capture and storage end to end, safely injecting, monitoring and containing 80,000 tonnes of CO<sub>2</sub> for more than a decade
2. We conceptualise, design, manage, and fund bench & in-field CCS projects with the best local and international researchers
3. We test novel technologies to determine their efficiency, accuracy, and confidence. Our work brings confidence to regulators, industry and the community.
4. Our Otway Research Facility has seen \$100m in investment in 10 years, making it the best in-field CCS research centre in the world.



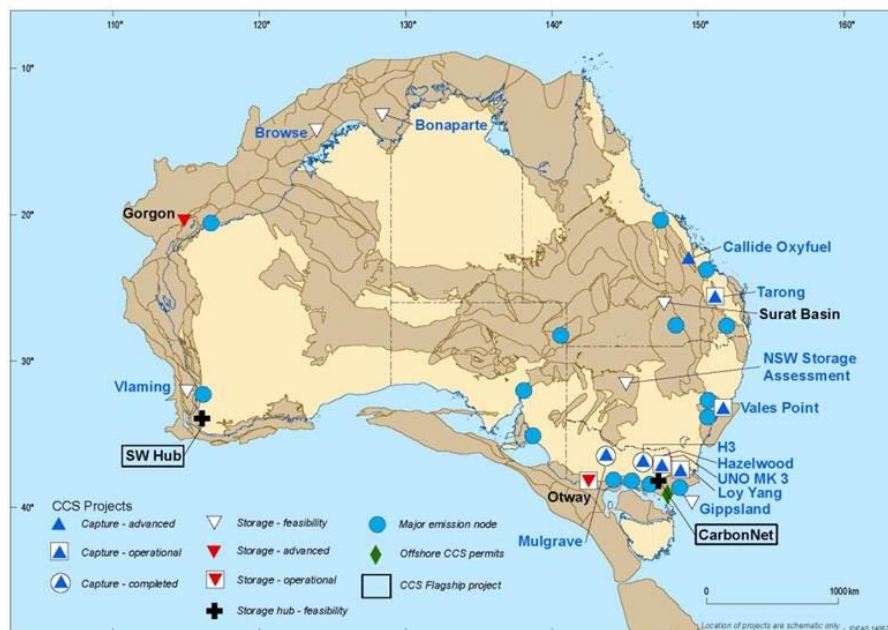
## WHO IS CO2CRC

CO2CRC SUPPORTS INDUSTRY TO REDUCE GREENHOUSE GAS EMISSIONS THROUGH CARBON CAPTURE & STORAGE RESEARCH

- ◊ We are the first company in Australia to have undertaken carbon capture and storage end to end
- ◊ Our research demonstrates carbon capture and storage in-field using novel technologies. We test their efficiency, accuracy and cost-effectiveness bringing confidence to industry and regulators
- ◊ We have safely injected, monitored and contained 80,000 tonnes of carbon dioxide for more than a decade
- ◊ We design, project manage and fund carbon capture and storage programs utilising the best international and local talent



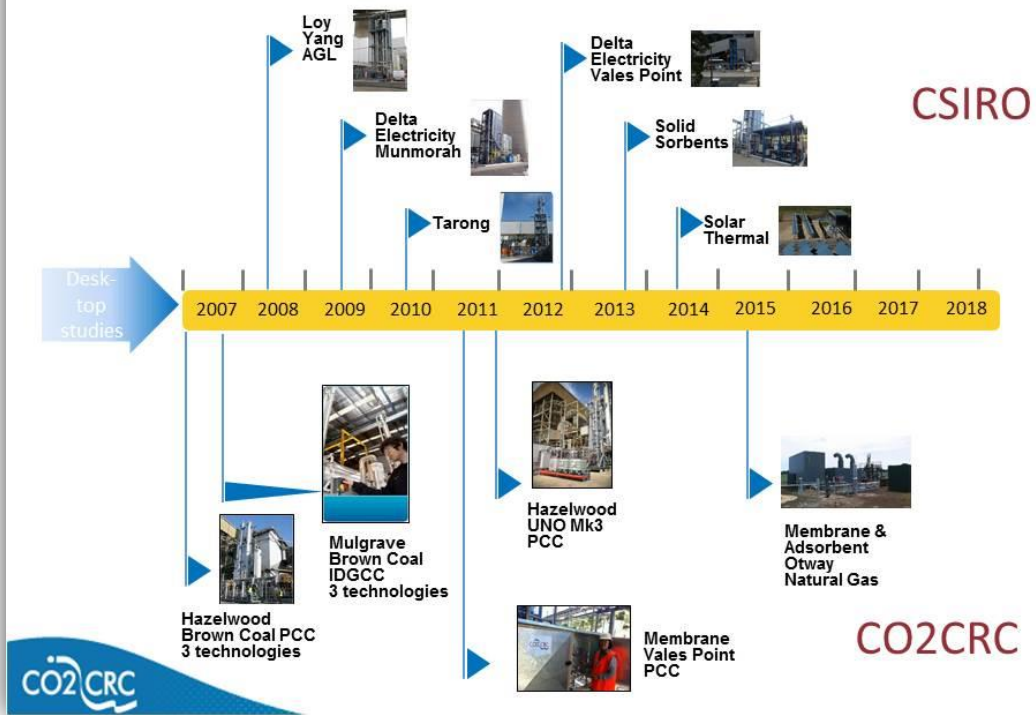
## Australian CCS Projects



Courtesy of Geoscience Australia; Image after CO2CRC



# What has Australian done in Capture?



# Capture

Unique capture projects aligned to Australian onshore and offshore natural gas projects

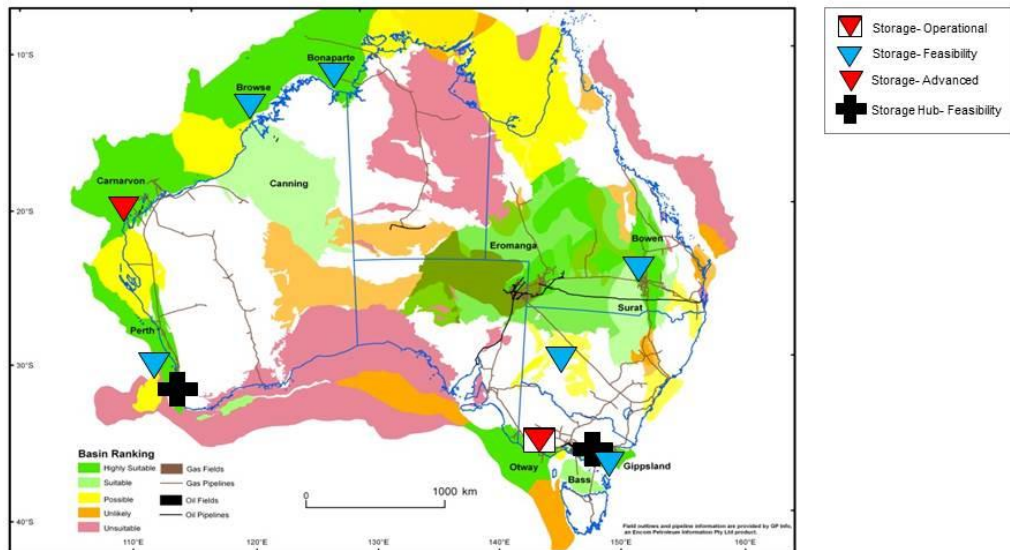


CO2CRC Otway Research Facility

- Demonstrate CO<sub>2</sub> capture from high-concentration natural gas fields offshore.



# Storage: national, basin-scale evaluation



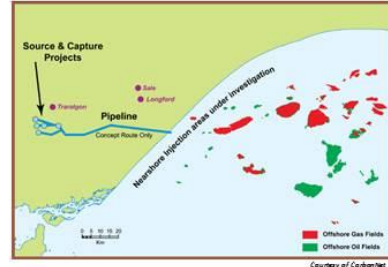
(Source: Carbon Storage Taskforce 2009)

# CCS Flagships: CarbonNet and SW Hub



## CarbonNet Project, VIC

- Proximal to major emissions, brown coal
- Hub concept, offshore storage
- Gippsland Basin, Latrobe sequence
- 1 to 5 million tonnes of CO<sub>2</sub> per year
- Identified a single site
- Feasibility stage, exploration permit



## SW Hub, WA

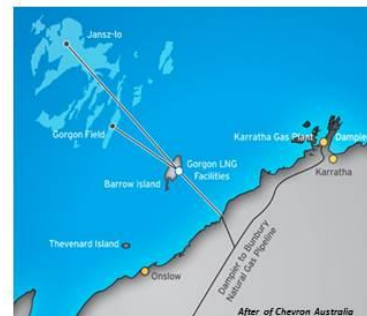
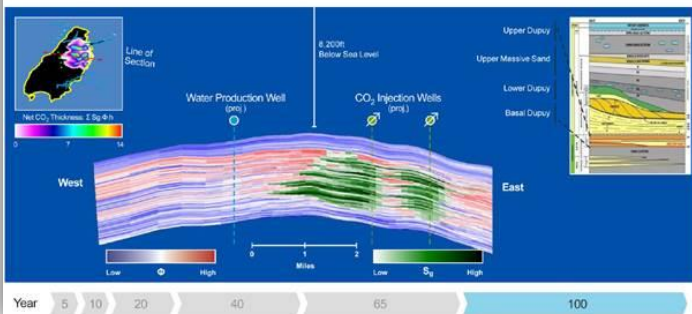
- Hub concept, onshore storage
- Southern Perth Basin, Lesueur Sandstone
- Aim 3.3 million tonnes of CO<sub>2</sub> per annum
- Pre-feasibility



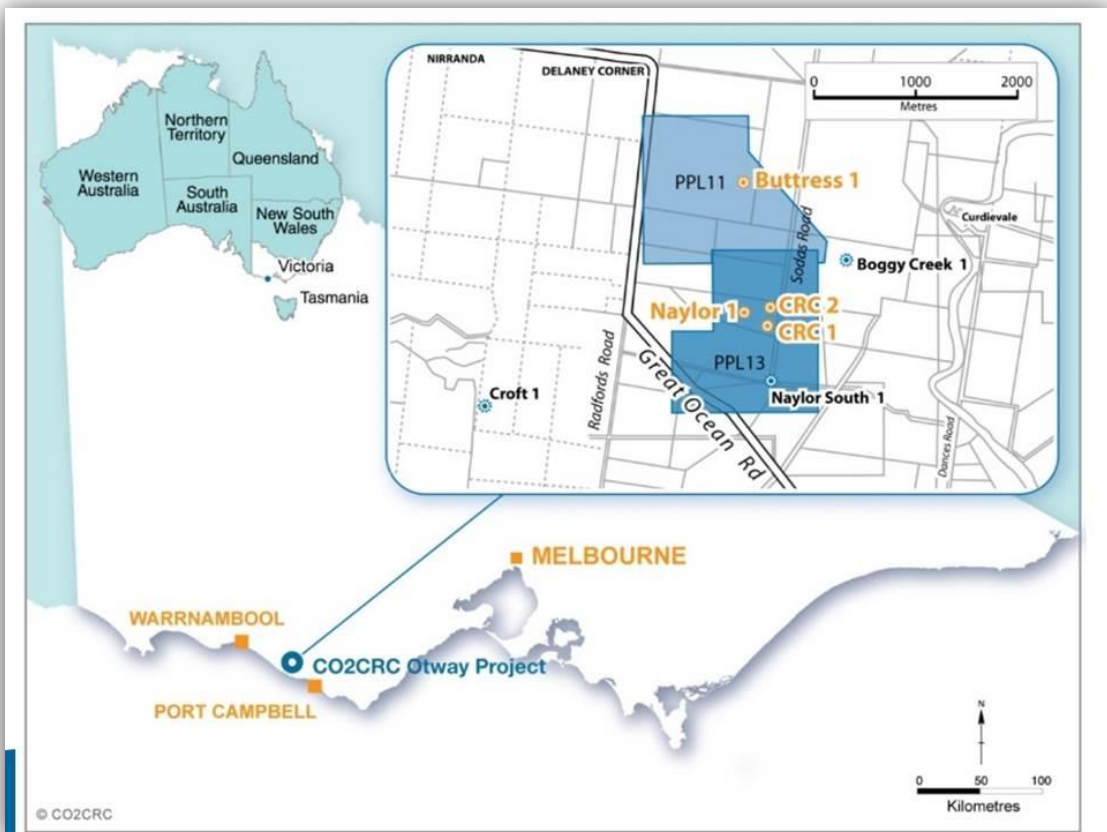
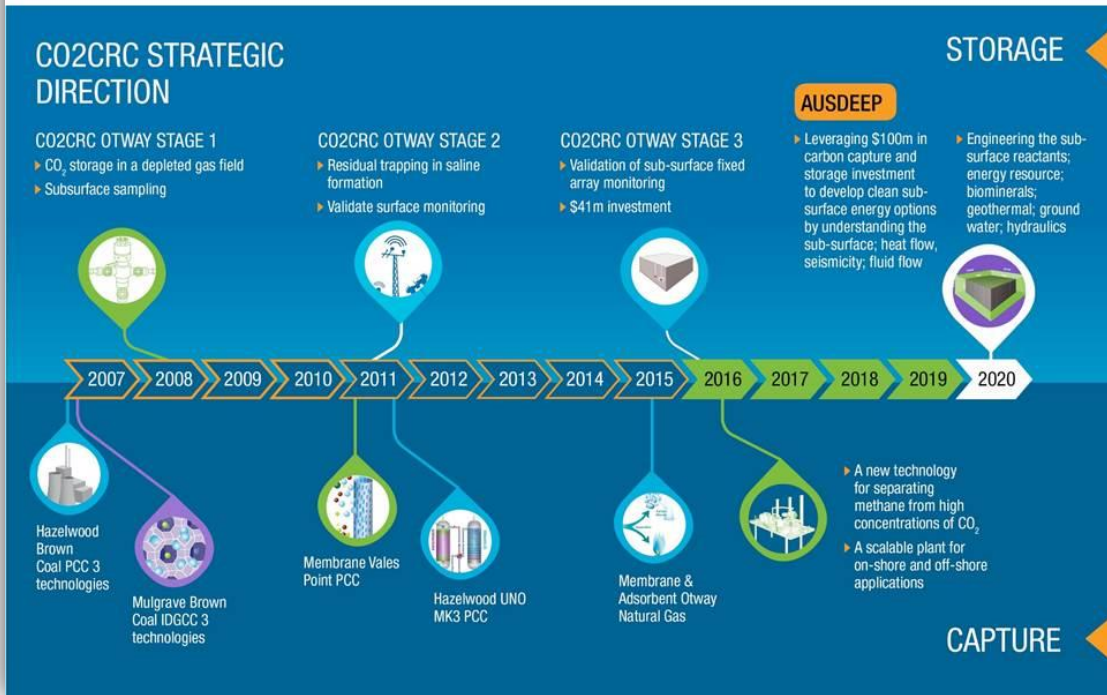
# The Gorgon Project:

Chevron and JV Partners

- Barrow Island, Dupuy Formation
- Natural gas processing (LNG)
- Nine injection wells: 3.4 and 4.0 MT of reservoir carbon dioxide each year
- Routine monitoring through well and/or seismic surveys
- Start-up of the second LNG train in late 2017



# CO2CRC strategic direction



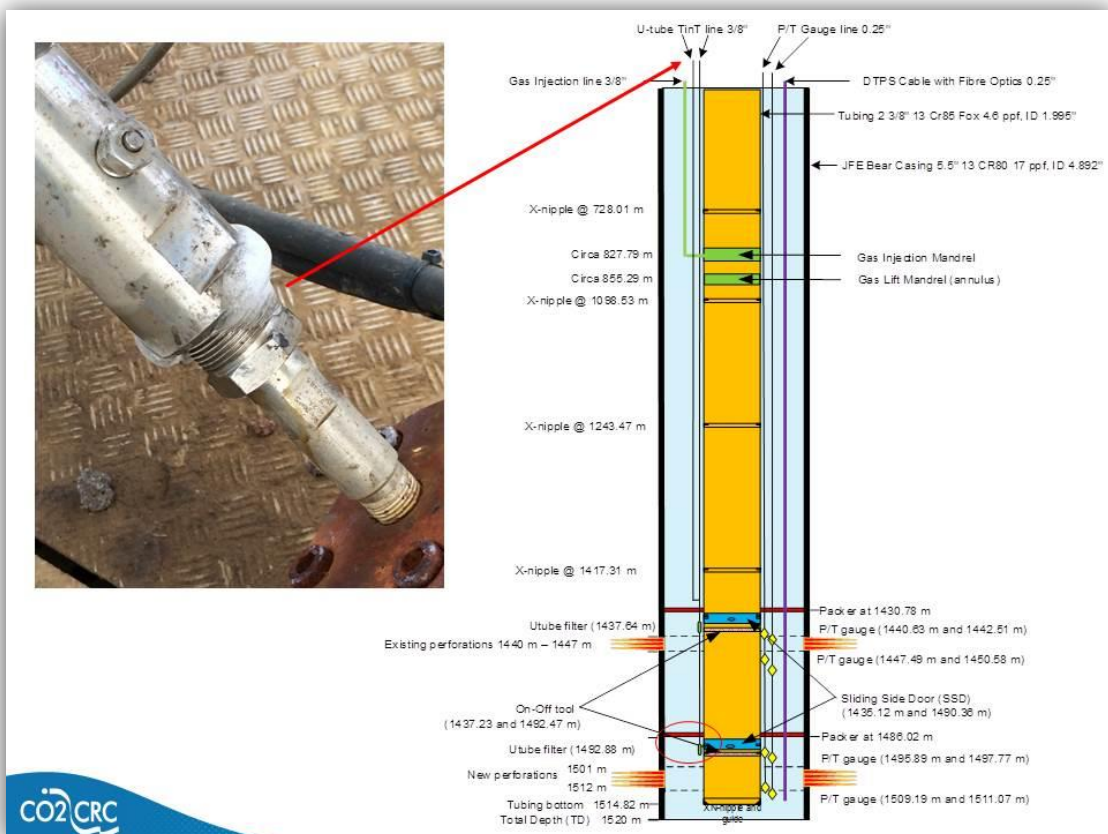
## Monitoring techniques

Downhole monitoring includes:

- DTS cable (Distributed Temperature Sensing fibre optics)
- 2x P/T (pressure/Temperature) gauges at the top and bottom of each perforation (therefore 8 gauges each);
- utubes (currently unused) for fluid sampling;
- Periodically running
  - VSP (vertical seismic profiling)
  - Pulsed Neutron logging for gas saturation

Assurance monitoring includes:

- Ground water of Port Campbell and Dilywn Formations
- Soil Gas monitoring



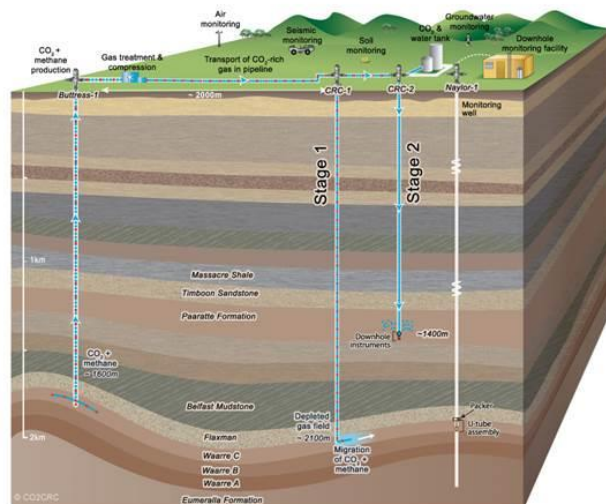
## Otway Project Principals

- Ensure human health and safety is protected at all times
- Safeguard ecosystems throughout project
- Ensure no impact to underground sources of drinking water and other resources
- Engage openly with community
- Comply with regulations
- Meet project objectives



## CO<sub>2</sub>CRC Otway Project Objectives

- **Stage 1: 2004–2009**
  - ✓ Demonstrate safe transport, injection and storage of CO<sub>2</sub> into a depleted gas reservoir
- **Stage 2: 2009–2019**
  - ✓ Demonstrate safe injection and monitoring into a saline formation
- **Stage 3: 2016–2028**
  - ✓ Demonstrate safe, reliable and cost-effective subsurface monitoring of CO<sub>2</sub>



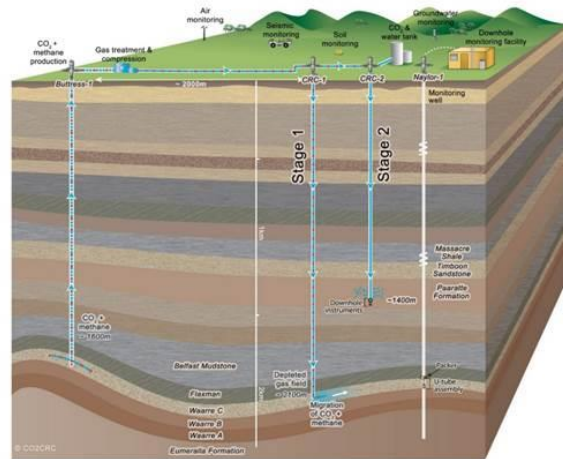


# The CO2CRC Otway Project Stage 2

Stage 2: 2007 – 2020

*Demonstrate that CO<sub>2</sub> storage can be safely conducted at scale within a Saline Formation*

- }
Appraisal
  - ✓ 2A :Drill CRC-2
  - ✓ 2B: Measure parameters affecting residual and dissolution trapping in a saline formation
  - ✓ 2B Extension: interactions with impurities & well test refinement
- }
Operation
  - 2C: Spatially track injected CO<sub>2</sub> in a saline formation
    - Minimum detection limit
    - Migration behaviour
    - Stabilisation



## Stage 2C Monitoring program

4D seismic with buried receiver array acquired concurrently with 4D VSP

- Baseline: March 2015
- Monitor surveys: 5 kt, 10kt, 15 kt of injection (2016), 1&2 years post injection (January 2017 & 2018)

Offset VSPs

Trialing 4D seismic with buried DAS array, and continuous seismic sources (LBNL)

Passive seismic using buried receiver array

Continuous in- & above-zone pressure monitoring

Saturation logging



**Geophone and fiber array installation:  
Trenches 80 cm deep, PVC cased boreholes 4 m deep**



**Seismic Array**

Installation of 1km seismic array.

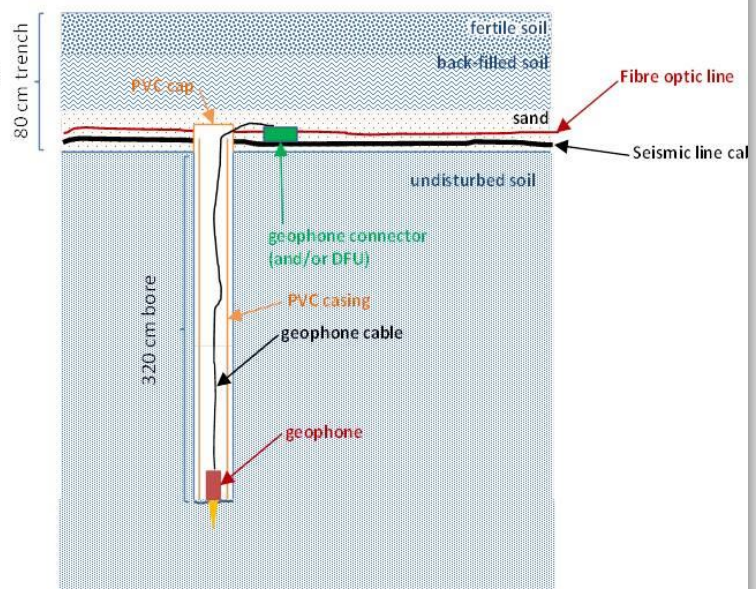
900 monitoring devices – geophones

Over 30km of fibre optic cable

Receivers buried 4 metres underground

Lines 100 metres apart, receivers 15 metres apart

Installed in early 2015



## Seismic Array

- 1 km seismic array
- Over 30 km of fibre optic cable.
- Fibre component of project led by LBNL



## Seismic Array

Over 900 geophones  
Permanently installed 4 metres  
below ground  
This part of project led by  
Curtin University





Geophones



Fibre optic cable



Deployed in Trench



## Otway Stage 2C preliminary results

1. 15,000 tonnes of CO<sub>2</sub>, safely injected into the saline formation, is migrating as predicted.
2. Seismic & pressure monitoring resolution is beyond expectation
3. Minimum detection levels of CO<sub>2</sub> have been identified
4. The combination of these results, with ongoing regular monitoring through to 2019, will de-risk the injection, monitoring and trapping of CO<sub>2</sub> in a saline formation giving confidence to technology users and regulators.



### DE-RISKING THE STORAGE OF CO<sub>2</sub> IN SALINE FORMATIONS

Saline formations have the greatest potential for CO<sub>2</sub> storage globally. Their utilisation will be necessary to ensure we remain within the COP21 2C target.

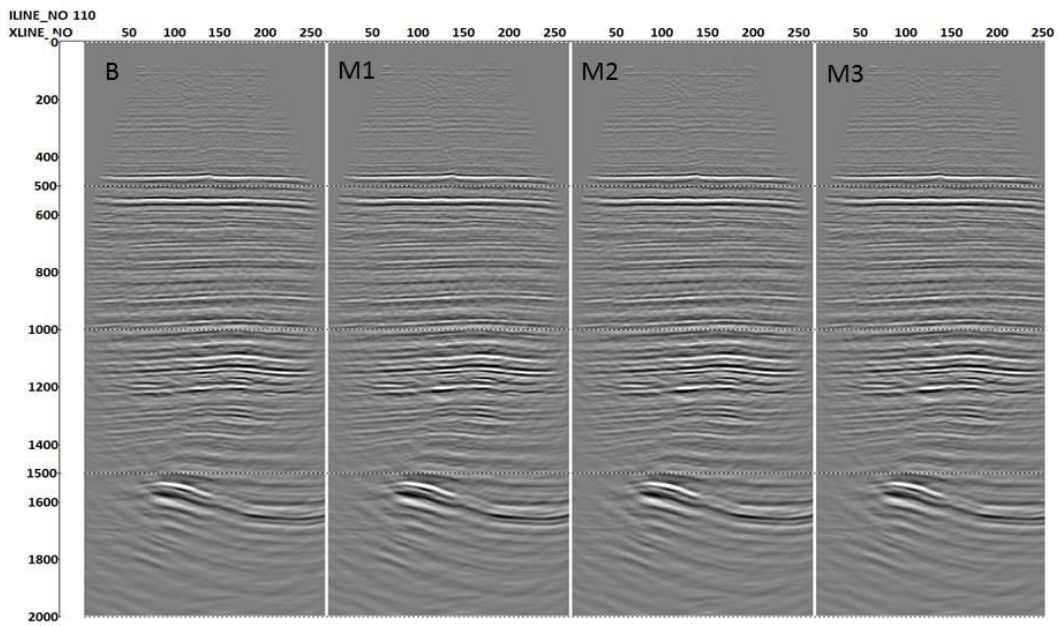
## 2015–2019



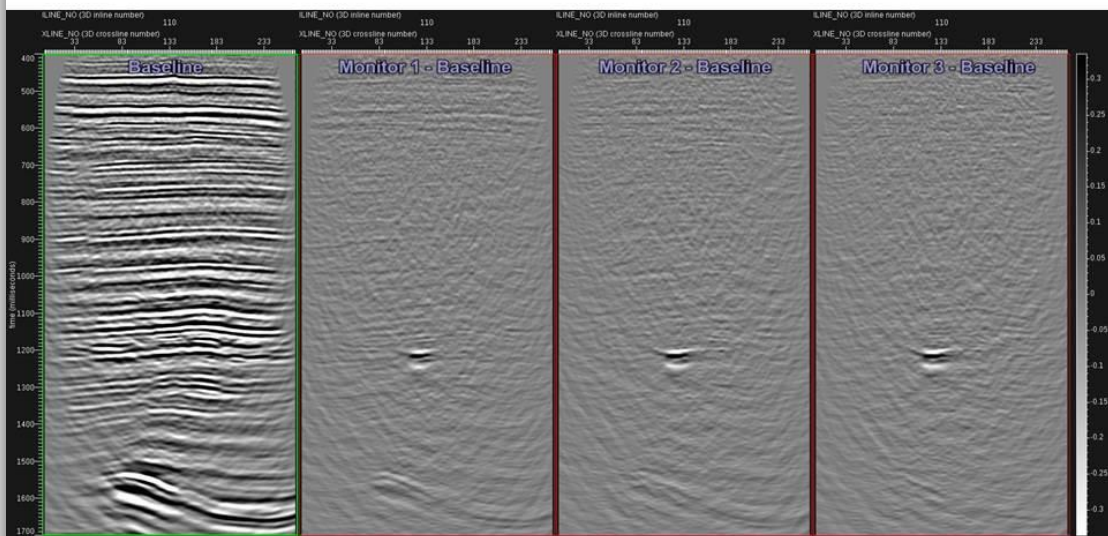
THROUGH THE MONITORING AND VERIFICATION OF 15,000 TONNES OF INJECTED CO<sub>2</sub> WE WILL VALIDATE SALINE ROCK FORMATIONS FOR CARBON CAPTURE AND STORAGE BY:

- |   |  |  |
|---|--|--|
| <b>A</b>  | <b>B</b>   | <b>C</b>   |
| VALIDATING THE ACCURATE MODELLING OF CO <sub>2</sub> STABILISATION AND TRAPPING IN A SALINE FORMATION | UNDERSTANDING THE SAFE STORAGE CAPACITIES OF THIS RESOURCE | DEMONSTRATING THE MINIMUM DETECTION LEVEL OF CO <sub>2</sub> |

## Otway Stage 2 – pre 4D



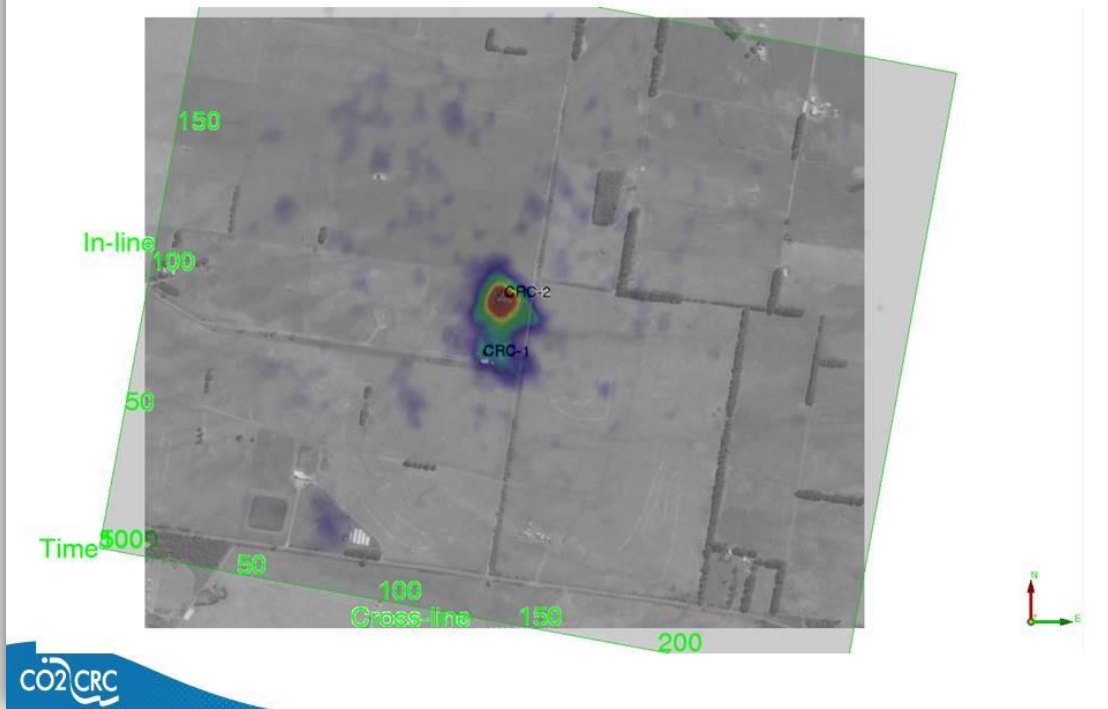
## Otway Stage 2 – 4D change still image



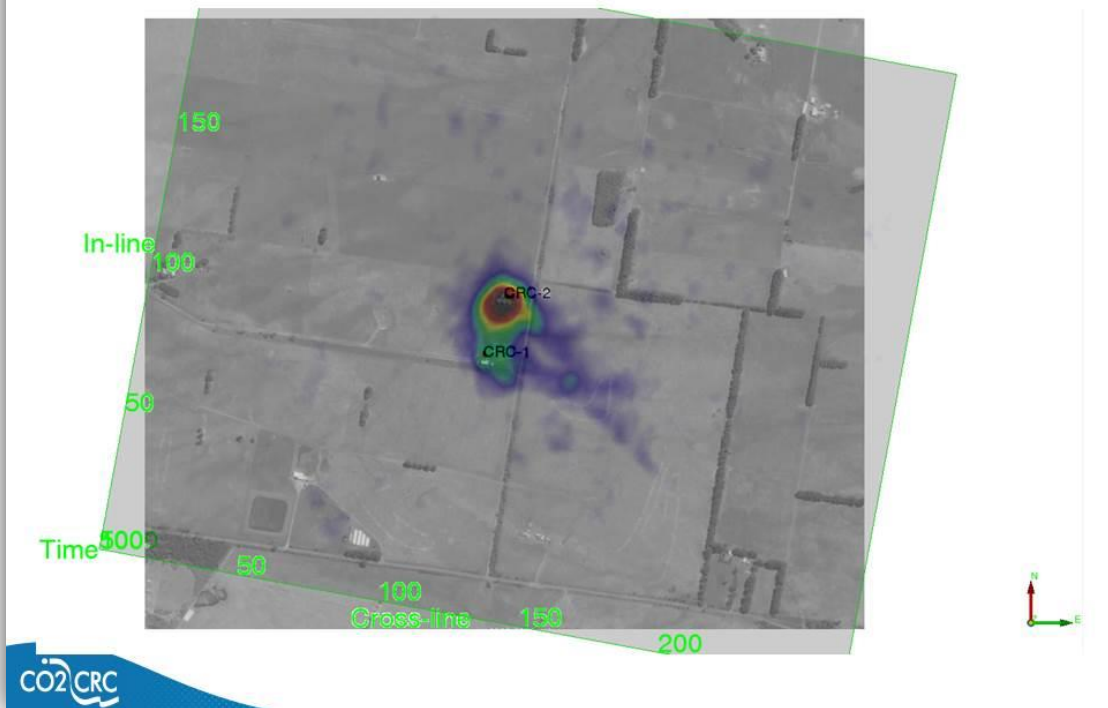
Supplementary video to the article: "4D surface seismic tracks small supercritical CO<sub>2</sub> injection into the subsurface: Otway Project"



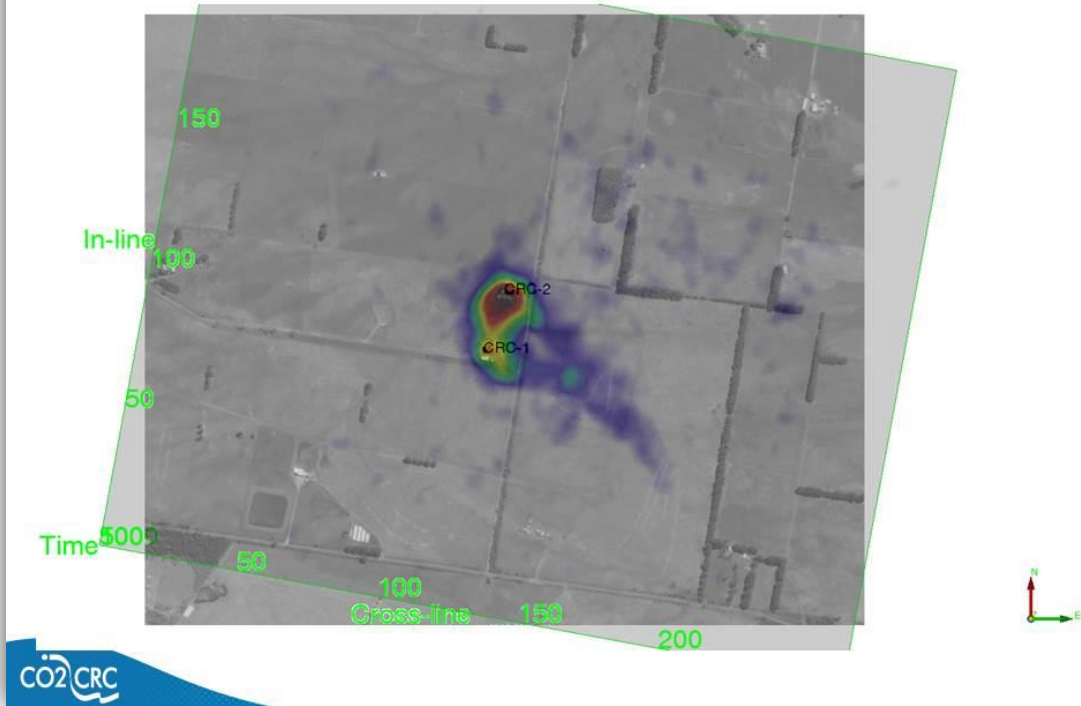
# Energy(M1 – B)



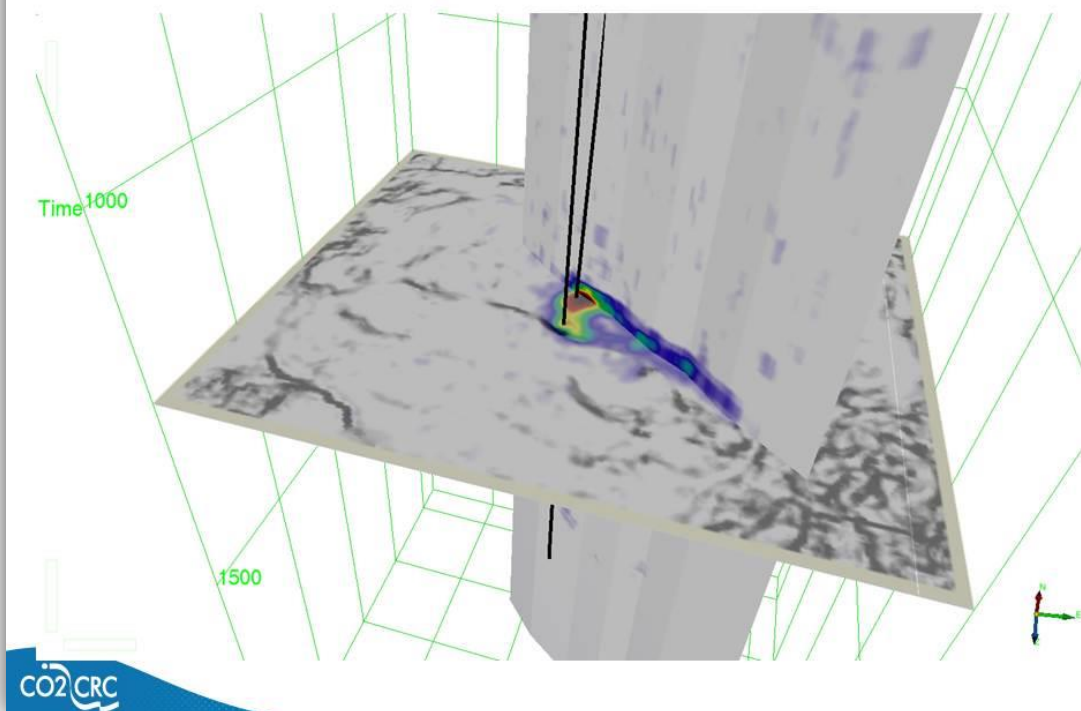
# Energy(M2 – B)



# Energy(M3 – B)



# Otway Stage 2



## Otway Stage 3 2016-2020 objectives

1. To deliver a permanently deployed subsurface and cost-effective real-time monitoring solution for industry
2. To increase the efficiency of CO<sub>2</sub> monitoring with new and adapted technologies
3. To reduce the surface footprint and impact of monitoring activities



## REDUCING THE COST OF CO<sub>2</sub> STORAGE

CO<sub>2</sub>CRC aims to accelerate the implementation of commercial carbon capture and storage projects by undertaking the validation of cost-effective subsurface monitoring technologies

# 2016–2020



BY 2020 WE WILL FULFIL THE FOLLOWING OBJECTIVES:

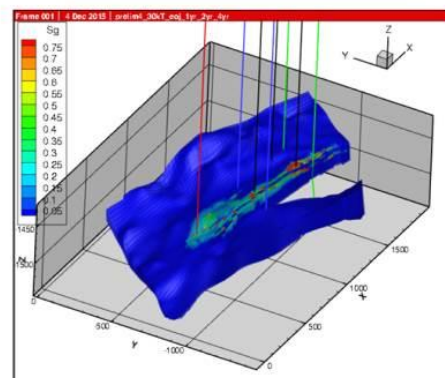
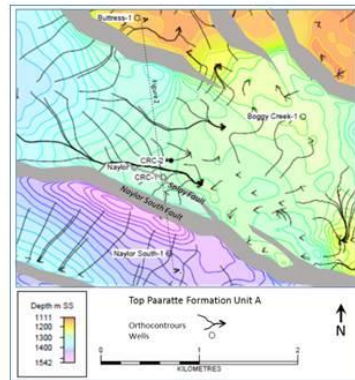
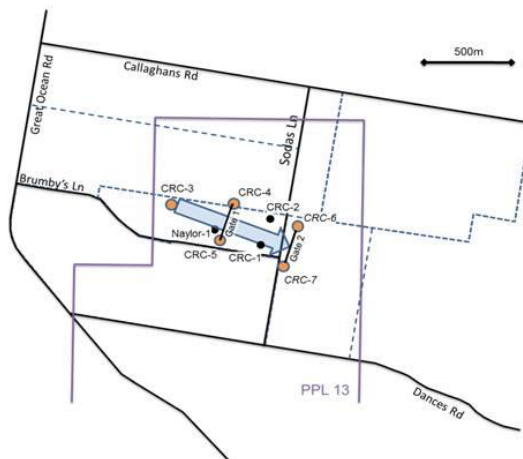


**A**  
DELIVERY OF PERMANENTLY DEPLOYED, COST-EFFECTIVE REAL-TIME MONITORING SOLUTIONS

**B**  
INCREASE CO<sub>2</sub> STORAGE MONITORING EFFICIENCY WITH NEW TECHNOLOGIES

**C**  
REDUCE THE SURFACE FOOTPRINT AND IMPACT OF MONITORING ACTIVITIES

## Otway Stage 3 Concept





## Storage Research & Development Program

### Geological Integrity

Methodologies and tools for uncertainty reduction in storage including improved methods for characterising fluid migration conduits

- ***Fault seal Integrity Characterisation***
- Top Seal Integrity Characterisation
- Geological Uncertainty

### Engineering Storage

Improved design guidelines for:

- pressure monitoring & management,
- optimising well design;
- up-scaling of simulations



## Storage Research & Development Program cont.

### Fit For Purpose M&V

Development of M&V techniques with reduced cost and risk to operators, while targeted to specific regulatory or societal requirements.

- Validation of subsurface M&V as alternative to surface M&V
- Improved geophysical M&V
- Passive seismic
- ***Near surface CO<sub>2</sub> Migration Prediction & Validation***
- Marine M&V

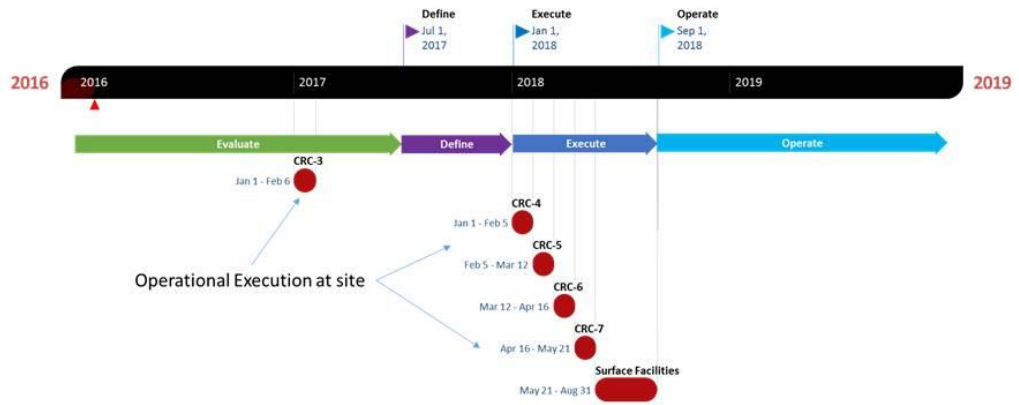
### Geochemical Engineering

Development of geochemical engineering solutions to assist in:

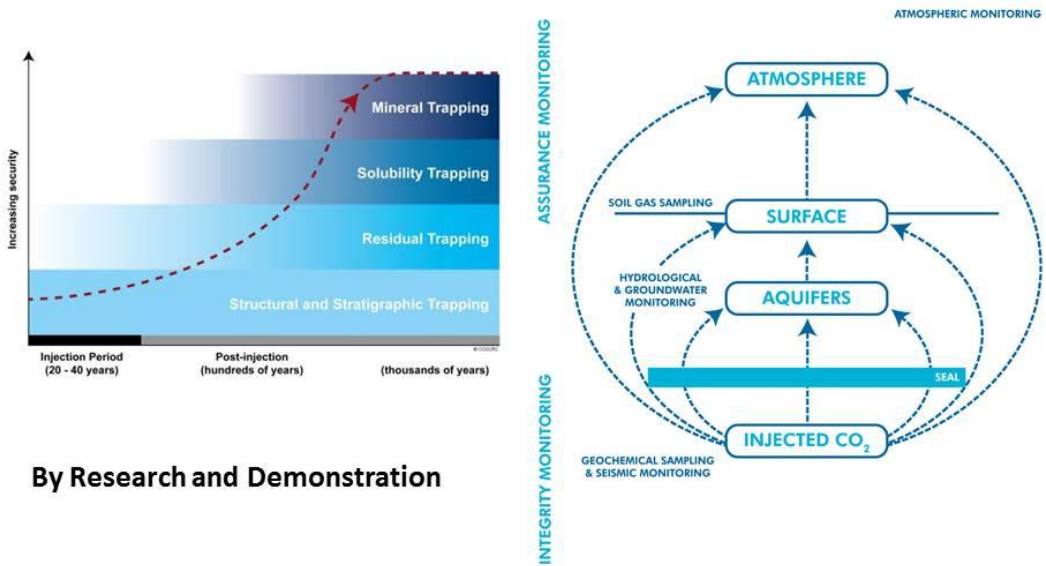
- Enhancing containment
- Enhanced injectivity.



# Otway Stage 3 Schedule



# Our Storage Program: Simplified



By Research and Demonstration

## Highlights of the Storage Projects

### Exceptional Datasets

- Atmospheric (continuous monitoring)
- Soil Gas
- Seismic
- Reservoir fluids



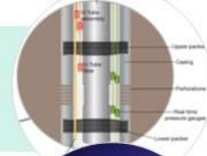
### Field Validation

- Validation of models in actual field tests
- Fully permitted and operational site
- Availability of CO<sub>2</sub>
- Globally unique advantage



### Developing Novel & Innovative Concepts & Technology

- Single Well Test for reservoir characterisation
- Several generations of U-Tube systems deployed
- Innovative well instrumentation



### First of its kind experiments

- First CO<sub>2</sub> storage demonstration project in Australia
- Reducing risk and uncertainty
- Advising regulators and project proponents in Australia and world
- A go-to project



## Government, Industry and Research Partners

